

GAO

Report to the Chairman, Subcommittee
on Clean Air and Nuclear Regulation,
Senate Committee on Environment and
Public Works

May 1993

NUCLEAR WASTE

Yucca Mountain Project Behind Schedule and Facing Major Scientific Uncertainties



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**Resources, Community, and
Economic Development Division**

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May 21, 1993

The Honorable Joseph I. Lieberman
Chairman, Subcommittee on Clean Air
and Nuclear Regulation
Committee on Environment and Public Works
United States Senate

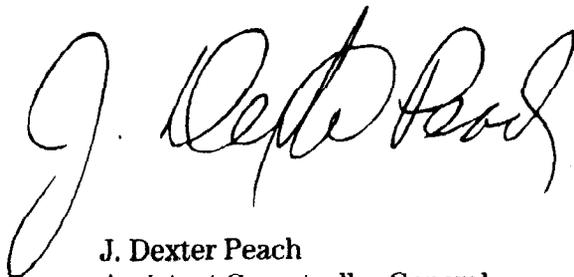
Dear Mr. Chairman:

The Chairman of the Subcommittee on Nuclear Regulation, the predecessor to your Subcommittee, requested that we review whether (1) the funding of the scientific investigation of Yucca Mountain, Nevada, as a potential site for a nuclear waste repository is sufficient to permit the Department of Energy (DOE) to meet its schedule and (2) initiatives by DOE to streamline the investigation could affect the investigation's scientific quality. As agreed with your office, we are providing our report on this request to you.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; and the Director, Office of Management and Budget. We will make copies available to others on request.

This work was performed under the direction of Victor S. Rezendes, Director, Energy and Science Issues, who can be reached on (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix II.

Sincerely yours,



J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

The accumulation of highly radioactive waste at over 70 civilian and Department of Energy (DOE) nuclear facility sites in 33 states created an environmental problem addressed in the Nuclear Waste Policy Act of 1982 (NWPA). The act made DOE responsible for developing an underground repository that was expected to be operational in 1998. By 1991, DOE was estimating that its scientific investigation of a site at Yucca Mountain, Nevada, could be completed in 2001 at a cost of \$6.3 billion in year-of-expenditure dollars and that, if the site proves to be suitable, a repository could be in operation in 2010.

Concerned about the progress of the investigation of Yucca Mountain, the Chairman of the Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, requested that GAO review whether (1) the level of funding will permit DOE to meet the current schedule for the investigation and, if not, how long it might take and (2) DOE's initiatives to streamline the investigation could affect its scientific quality. This report presents the results of GAO's review of these two issues and raises a number of questions about the pace and direction of the nuclear waste disposal program. GAO intends to address these additional questions in its upcoming report, required by NWPA, on the program.

Background

As originally enacted, NWPA required DOE to investigate three repository sites and, upon the formal selection of one, apply to the Nuclear Regulatory Commission (NRC) for a license to construct a repository. The owners and generators of the waste—primarily utilities operating nuclear power plants—were required to pay fees into the Nuclear Waste Fund, which is included in the federal budget and may be used only for activities concerning waste disposal. The act also authorized DOE to enter into disposal contracts with the owners and generators. The contracts were required to provide that, in return for payment of fees, DOE would begin disposing of waste by January 31, 1998.

Amendments to NWPA in 1987 directed DOE to investigate only the Yucca Mountain site and created the Nuclear Waste Technical Review Board to independently review the disposal program. The amendments also authorized DOE to develop an above-ground facility for temporarily storing nuclear waste prior to permanently disposing of it in a repository but prohibited the construction of the facility until NRC has issued a license for the construction of the repository. Nevertheless, DOE has wanted to develop a storage facility on a schedule that would permit the agency to begin accepting nuclear waste for temporary storage in 1998. To achieve

this objective, DOE has relied on the Nuclear Waste Negotiator, a position established by the amendments, to negotiate with a state or Indian tribe terms acceptable to the Congress under which the state or tribe would agree to host a temporary storage facility on DOE's schedule.

Results in Brief

At its present pace, DOE's investigation of Yucca Mountain will take at least 5 to 13 years longer than planned and cost more than the agency has projected. One reason is that DOE has not been requesting the amounts of funds that it has estimated are needed to maintain the project's schedule. Also, investigating the site competes for available funds with the agency's other objectives within the disposal program, such as accepting nuclear waste in 1998. Furthermore, DOE has used most of the funds allotted to the project to maintain a project infrastructure that is large enough to support the agency's objective of completing the investigation in 2001. Thus, although the ultimate objective of NWPA is the potential development of a repository, DOE has been spending relatively little of the available funds to perform essential investigation activities at Yucca Mountain. In fiscal year 1992, for example, the agency spent only \$60 million on site investigation activities, or 22 percent of the \$275 million appropriated for the disposal program.

DOE is pursuing two initiatives to maintain its schedule for the Yucca Mountain Project and reduce the project's cost. First, DOE wants to increase the funding for the disposal program by changing the way that funds for the program are provided in the federal budget. Although the details of the agency's proposal are few, it appears that DOE is considering legislation that would establish a revolving fund for the program. This initiative could permit increased use of the revenues in the Nuclear Waste Fund in accomplishing the purposes for which the fund was established but could also hinder efforts to control the deficit and may reduce congressional control over the disposal program. Second, in order to maintain the project's schedule, DOE recently compressed the time permitted for various scientific studies and, to reduce costs, is considering similar reductions in the project's scope. This initiative could increase the risk that the site investigation will be inadequate and comes at a time when unanticipated technical issues have emerged that could lengthen the investigation.

DOE's initiatives do not comprehensively address the disposal program's basic condition, which has been exacerbated, if not caused by, a disconnection between funding and policy. Specifically, although DOE gave

relatively high funding priority to keeping on track its plans to accept waste by 1998 at a temporary storage facility, it is now almost certain that the agency will not have such a facility available by then or soon thereafter. Yet, a realistic date for having a permanent repository operational keeps receding farther into the future, in part because of the relatively low funding priority the agency has assigned to essential scientific and technical activities. These conditions raise significant questions about the pace and direction of the program that must be answered if it is to proceed in an orderly fashion.

Principal Findings

The Low Priority Accorded to Investigating the Site

DOE developed a schedule for completing the investigation of Yucca Mountain by 2001 and estimated the annual cost of the project but then did not request sufficient funds each year to maintain the schedule. For example, in fiscal years 1991 through 1993, the agency requested \$613 million, or 53 percent of the \$1.159 billion that it had estimated would be needed in those years to maintain the project's schedule. This disparity was due to competing budgetary priorities; the budget request for the disposal program was only about 2 percent of the agency's total request for energy appropriations.

In allotting funds appropriated for the disposal program, DOE has used some to pursue its objective of accepting nuclear waste at a temporary storage facility by 1998. For fiscal year 1992, for example, DOE allotted \$109 million of the program's appropriation of \$275 million to activities related to accepting waste and pursuing other objectives within the program and allotted the remaining \$166 million to the Yucca Mountain Project. DOE used \$106 million of the project's allotment on what the agency terms "infrastructure activities" supporting the scientific investigation of Yucca Mountain, such as managing the project and interacting with NRC and others. This left only \$60 million for activities directly related to the site investigation, for instance, collecting site-specific data. As a result of such decisions about funding, the investigation is behind schedule, and GAO estimates that continued funding at similar amounts could add at least 5 to 13 years to the investigation's schedule and \$230 million to \$600 million to the costs of managing the project alone.

The Nuclear Waste Technical Review Board has also expressed concern about the project's "large and unwieldy" organizational structure and the high proportion of funds allocated to infrastructure activities. For these reasons, the Board recommended an independent evaluation of the program's management and organization.

Initiatives to Streamline the Site Investigation

DOE wants to change the existing practice of providing new budget authority for the disposal program in annual energy and water development appropriations acts by apparently establishing a revolving fund for the program. DOE's view is that, because the program has a specific purpose and is financed by the owners and generators of nuclear waste, the program should be funded according to its merits rather than according to its ability to compete for limited appropriations with other programs funded from general revenues to the Treasury and from other special funds. DOE's proposal appears to have the advantage of making more of the revenues in the Nuclear Waste Fund available for the agency's use in implementing NWPA. But there are other factors that need to be weighed in considering such a proposal. Considered in the context of the overall federal budget, for example, DOE's proposal would increase the federal deficit unless spending was reduced in other areas and could reduce congressional oversight and control of the program. Also, any significant increase in annual funding of the disposal program, whether achieved by changing the method for funding the program or by larger appropriations under the present method of funding, could, if not carefully monitored, adversely affect the long-term financial health of the Nuclear Waste Fund.

DOE recently compressed some planned studies to maintain the project's schedule without considering the effects of this action on the quality of the site investigation. The agency is also considering further reductions in the scope of scientific investigations to reduce costs. DOE has often been criticized for overemphasizing the schedules for its disposal program. Regarding the recent initiative, project scientists have expressed concern that DOE, by shortening the planned duration of some studies, may not allow sufficient time to investigate the site and, therefore, may increase the risk associated with demonstrating that the site meets all requirements for licensing.

Moreover, the Nuclear Waste Technical Review Board has concluded that, by adhering to the project's current schedule, DOE may not be allowing enough time to resolve emerging technical issues. The Board

recommended, for example, that DOE evaluate alternative strategies for managing the heat generated by waste in the repository by conducting tests that the agency had not planned to perform. The Board has urged DOE not to allow a schedule to drive the scientific and technical aspects of the disposal program.

Recommendation to the Secretary of Energy

Because of concerns over the slow pace and fragmented direction of the disposal program, GAO recommends that the Secretary of Energy review the program's goals and objectives in the context of the program's priority for funding. Such a review should address whether the program's emphasis on the scientific investigation of Yucca Mountain is sufficient and how that investigation can be conducted more efficiently without sacrificing its technical quality.

Recommendation to the Congress

GAO recommends that the Congress defer consideration of changing the method for funding the disposal program until the Secretary of Energy has completed the review recommended by GAO and until an independent review of the program, as recommended by the Nuclear Waste Technical Review Board, has also been completed.

Agency Comments

GAO discussed the facts presented in this report with the acting director of DOE's disposal program and other officials of the agency. These officials agreed with the facts presented in this report, and GAO incorporated the officials' comments as appropriate. As requested, GAO did not obtain written agency comments on a draft of this report.

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Abbreviations

DOE	Department of Energy
GAO	General Accounting Office
MRS	monitored retrievable storage
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act of 1982
OCRWM	Office of Civilian Radioactive Waste Management
OMB	Office of Management and Budget
YMPO	Yucca Mountain Project Office

Introduction

Radioactive waste creates potential risks to public health and safety and the environment and requires safe and environmentally acceptable methods of disposal. The accumulation of spent fuel from civilian nuclear power plants and highly radioactive waste from the production of nuclear weapons has created a national problem. As these wastes accumulate, they are being stored temporarily in more than 30 states—at over 70 nuclear plant sites, other nuclear facilities, and three federally owned sites. Some of these nuclear plants are running out of storage space and are either adding to or planning to add to their storage capacity.

The Congress enacted the Nuclear Waste Policy Act of 1982 (NWPA) to provide for the development of repositories for the disposal of radioactive waste. The Congress had found, among other things, that previous federal efforts to devise a permanent solution for disposing of this waste were not adequate and that highly radioactive waste had become a subject of great concern to the public. In enacting the act, the Congress explained that appropriate precautions must be taken to ensure that such waste does not adversely affect public health and safety and the environment for this or future generations.

The Nuclear Waste Policy Act of 1982

As originally enacted, NWPA established a schedule for siting, licensing, constructing, and operating geologic (underground) repositories to permanently dispose of highly radioactive waste. The act assigned responsibility for permanently disposing of the waste to the federal government and created, within the Department of Energy (DOE), the Office of Civilian Radioactive Waste Management (OCRWM) to manage the program for disposing of nuclear waste from civilian nuclear power plants. The Secretary of Energy was to recommend to the President three candidate repository sites for characterization (scientific investigation), and following the characterization of the candidate sites, the President was to recommend to the Congress one of the three for the construction of a repository.

Upon the selection of a repository site, the Secretary of Energy was to submit to the Nuclear Regulatory Commission (NRC) an application for authorization (a license) to construct a repository. To obtain a license from NRC, DOE must demonstrate that the construction and operation of a repository will comply with NRC's regulatory requirements and environmental standards set by the Environmental Protection Agency. A schedule was also provided for a second repository.

In addition to guiding the development of repositories, the act directed the Secretary of Energy to study the need for and feasibility of one or more federally owned and operated monitored retrievable storage (MRS) facilities for highly radioactive waste and to submit to the Congress a proposal for constructing one or more such facilities.¹

The act made the federal government responsible for providing for the permanent disposal of high-level waste and such spent fuel as may be disposed of in order to protect the public health and safety and the environment but generally held those who generate and own the waste (usually utilities) responsible for paying for authorized disposal activities. In 1985, the President decided that DOE's high-level wastes generated from nuclear weapons production would also be disposed of in the repository. Therefore, DOE is required to pay its fair share of the cost of the disposal program.

Under the act, DOE was authorized to enter into contracts with the generators and owners of the waste for the acceptance, subsequent transportation, and disposal of such waste. These contracts were required to provide that (1) after the repository begins operations, DOE will take title to nuclear waste as soon as practicable upon request and (2) in return for the payment of fees, beginning not later than January 31, 1998, DOE will dispose of the waste as provided in the act.² The fees are deposited into the Nuclear Waste Fund. The fund, established under the act, is included in the Budget of the United States Government and may be used only for purposes of radioactive waste disposal activities.

1987 Amendments to the Nuclear Waste Policy Act

In May 1986, the Secretary of Energy recommended, and the President selected, sites in Deaf Smith County, Texas; on DOE's Hanford Reservation, in Washington State; and at Yucca Mountain, Nevada (partially on DOE's Nevada Test Site), for investigation as candidate sites for a repository. The Secretary also suspended the search for sites for a second repository. Subsequently, in June 1987, DOE announced a 5-year delay in its schedule for beginning to operate a repository (from 1998 to 2003).

¹The act defined storage as the retaining of waste, with the intention of recovering it for subsequent use, processing, or disposal.

²DOE's standard disposal contract provides that:

"The services [including acceptance of title, subsequent transportation to the DOE facility, and disposal] to be provided by DOE under this contract shall begin, after commencement of facility operations, not later than January 31, 1998 and shall continue until such time as all SNF [spent nuclear fuel] and/or HLW [high level radioactive waste] from the civilian nuclear power reactors . . . has been disposed of." 10 CFR S 961.11, Article II - SCOPE.

DOE found mounting opposition from states in which the potential sites were located and increasing estimates of the costs to investigate those sites. In December 1987, the Congress amended NWPA, directing DOE to characterize only the Yucca Mountain site to determine its suitability for a repository.³ If the Secretary of Energy finds the site suitable and the site is formally selected, DOE will submit an application to NRC to construct the repository there. If, however, the Secretary determines at any time that the site is unsuitable for a repository, he or she must stop all characterization activities and, within 6 months after making such a determination, make recommendations to the Congress for further actions, including the need for new legislative authority.

The 1987 amendments also authorized DOE to develop an MRS facility but linked the selection of a facility site to the schedule for a repository. The Secretary of Energy is permitted to select a site for an MRS facility only after characterizing a repository site and recommending to the President that the site be selected. Likewise, the construction of an MRS facility cannot begin until NRC authorizes the construction of the repository. When the Congress enacted the 1987 amendments, DOE anticipated obtaining from NRC a license for the repository early in 1998.

The 1987 amendments also established the Office of the Nuclear Waste Negotiator. The nuclear waste negotiator, who heads the Office, is empowered to negotiate an agreement with the governor of a state or with an Indian tribe to host an MRS facility or repository at a technically qualified site on reasonable terms. Any such agreement would not be effective unless enacted into law. If, as a part of a negotiated agreement, a state or tribe agreed to accept an MRS facility either without having the project linked to the repository's schedule or with the two projects linked in some way different from the current arrangement, the Congress could, if it chose to accept this agreement, remove or modify the existing statutory links.

Finally, the 1987 amendments created the Nuclear Waste Technical Review Board as a source of independent review of the scientific and technical activities undertaken by OCRWM in managing highly radioactive wastes. The Board is composed of scientific and technical experts nominated by the National Academy of Sciences and appointed by the President. The Board is required to issue reports at least twice a year to the Congress and the Secretary of Energy on its findings, conclusions, and

³The Nuclear Waste Policy Amendments Act of 1987, contained in Subtitle A of title V of the Omnibus Budget Reconciliation Act of 1987 (P.L. 100-203).

recommendations. As of March 1993, the Board had issued six semiannual reports and one special report.

The Secretary of Energy's Reassessment of the Disposal Program in 1989

Before underground exploration of the Yucca Mountain site could begin, NWPA, as amended, required DOE to submit a general site characterization plan for review and comment to NRC, the governor and legislature of Nevada, and the public. In December 1988, DOE issued the Yucca Mountain Site Characterization Plan, which described the scientific studies that the agency deemed necessary to determine the suitability of Yucca Mountain as a site for a nuclear waste repository. NRC, the state of Nevada, and others commented on the plan. At that time, DOE intended to (1) begin constructing an underground test facility, now called the exploratory studies facility, in 1989; (2) complete site characterization and submit a license application to NRC in 1995; and (3) begin constructing a repository in 1998 and begin operating it in 2003.

In November 1989, the Secretary of Energy reviewed the disposal program and, in a report to the Congress, concluded that the program could not be effectively executed in its then-current form.⁴ Therefore, the Secretary stated, DOE put together a realistic schedule, on the basis of experience and the information developed for the site characterization plan, that showed a 7-year slip in the expected start of operations at the repository, from 2003 to approximately 2010. In conjunction, the Secretary established an interim objective of completing site characterization and submitting a license application to NRC in October 2001. This new milestone for submitting an application was also about 7 years later than under the previous schedule. Under that schedule, DOE anticipated that a license to construct a repository would be granted in late 2004 and, therefore, that the agency would not be permitted to begin constructing an MRS facility until then because of the statutory link between its construction and the progress in developing a repository. The Secretary also stated that DOE would work with the Congress to modify the statutory links between the repository and the MRS facility and embark on an aggressive program to develop an MRS facility and begin accepting spent fuel there by 1998 or soon thereafter.

Finally, the Secretary stated that DOE was developing baselines of the technical status, schedule, and cost of the Yucca Mountain Project to define criteria and objectives for it. When problems potentially affecting

⁴Report to the Congress on Reassessment of the Civilian Radioactive Waste Management Program (DOE/RW-0247, Nov. 28, 1989).

the baselines were detected, action would be taken to solve or mitigate the problems or, alternatively, to modify the baselines. Changes to the baselines could only be made by means of a formal procedure involving a systematic review by the appropriate level of management to ensure that the effects of proposed changes were identified and weighed in the decision-making.

According to the Director, OCRWM, the baselines for the Yucca Mountain Project constitute DOE's management plan for the project and must be adhered to if DOE is to meet its objective of applying in 2001 for a license to construct a repository. The technical baseline was derived primarily from the site characterization plan. The plan identified over 6,000 discrete activities and defined the functional and technical requirements necessary to determine the site's suitability and prepare a license application. The schedule baseline established the milestones required to complete the technical baseline and submit a license application to NRC in 2001. The cost baseline established an estimated total cost to complete the activities included in the technical baseline. DOE estimated the total cost at \$5.7 billion in constant 1992 dollars, including about \$874 million in costs that had been incurred through the end of fiscal year 1990. DOE also estimated the total cost in year-of-expenditure dollars at about \$6.3 billion.⁵

DOE's Energy System Acquisition Advisory Board, which is the agency's highest level for controlling programs and projects, reviewed and approved the cost and schedule baselines in December 1991.⁶ According to the director of OCRWM, this top-level departmental approval was significant because it gave OCRWM independent authority and approval to its project plans and gave the Office confidence in its schedules and budget requirements.

Objectives, Scope, and Methodology

The Chairman, Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works, requested that we review DOE's progress in characterizing the Yucca Mountain site and identify potential impediments to completing the site characterization on schedule. As a result of discussions with the Chairman's office, we agreed to review

⁵In making this estimate, DOE applied escalation rates to the constant dollar estimates for each year between 1993 and 2002; these rates ranged between 4 percent and 5.8 percent.

⁶Chaired by the Under Secretary of Energy, the Energy System Acquisition and Advisory Board is an independent, high-level board that reviews and evaluates the viability of plans and budgets for projects of particular significance to DOE.

- whether the current level of funding will permit DOE to meet its schedule for the Yucca Mountain Project and, if not, how long site characterization might take and
- whether DOE's initiatives to streamline the site characterization could affect its technical quality.

To determine if the level of funding will permit DOE to meet its schedule for the Yucca Mountain Project, we reviewed the costs and schedule of the project, including the agency's annual budget requests and allotments of appropriated funds and the distribution of funds within the project itself. In carrying out our work, we reviewed budgetary information for fiscal years 1988 through 1994, a period encompassing 4 of the 11 years (1991 through 1994) included in the cost baseline. We reviewed the baseline funding estimate and field work proposals developed by the Yucca Mountain Project Office (YMPO), which is the organization within OCRWM that is responsible for characterizing the site. We also reviewed OCRWM's internal review budgets, funds earmarked for the Yucca Mountain Project from annual budget requests for the nuclear waste disposal program, the funding levels approved by the Office of Management and Budget (OMB), congressional appropriations from the Nuclear Waste Fund, and the appropriated funds allotted by OCRWM to the Yucca Mountain Project.

Also, we discussed the project's scientific and technical progress to date and the likelihood of meeting the project's milestones with knowledgeable DOE officials at YMPO, in Las Vegas, Nevada, and OCRWM, in Washington, D.C., and with project scientists at DOE's Lawrence Livermore National Laboratory in Livermore, California, and at the U.S. Geological Survey's office in Denver, Colorado.

To estimate how long it might take DOE to complete the planned site characterization, we broke down estimated costs for the project into those directly associated with scientific investigations and those that support, but do not directly advance, planned investigations. Specifically, through discussions with YMPO officials about the project's accounting system, we identified the costs for scientific and technical activities of the site characterization project and the costs of supporting the scientific and technical activities. DOE describes these latter costs as "infrastructure costs." Scientific and technical activities include collecting and analyzing site-specific scientific and technical data; developing a package for disposing of waste; establishing the technological basis for the repository; and designing, constructing, and operating an underground facility for characterizing the site. Infrastructure costs are incurred, according to DOE,

to (1) manage the activities of the project's contractors; (2) provide financial and technical assistance to Nevada, local governments, and the University of Nevada; (3) operate and maintain facilities and equipment; (4) comply with applicable laws and regulations; and (5) provide training to project staff, for public outreach, and for a quality assurance program.

We compared (1) the annual funding that the scientific and technical activities and the supporting activities would receive if the project was funded at the levels in the cost baseline and (2) the actual amounts received. We estimated how long it might take DOE to fund all of the baseline scientific and technical activities if the agency continued to allot funds to the Yucca Mountain Project at levels similar to recent ones, which have been below the baseline amounts. In making this estimate, we assumed that DOE would distribute the project's annual allotments of funds between the scientific and technical activities and the supporting activities in the same proportion as in the cost baseline. For this analysis, we assumed that DOE's technical and schedule baselines were reasonable and that the amounts in the cost baseline were reasonable estimates of the annual costs to complete the planned scientific and technical work. (See app. I for a detailed discussion of our methodology.)

To determine if DOE's initiatives to streamline the site characterization project could affect its technical quality, we reviewed DOE's September 1992 study addressing the possibility of meeting the milestone for applying for a license,⁷ and we reviewed documents related to other potential cost-cutting initiatives DOE is considering. We discussed these documents with YMPO's manager, other DOE officials, and project scientists at DOE's Livermore laboratory and at the Geological Survey's Denver regional office. Finally, we reviewed documents, prepared by NRC and the Nuclear Waste Technical Review Board, addressing DOE's site characterization project. From this information, we identified two emerging technical issues that were raised by project scientists and the Board after DOE had established its technical, schedule, and cost baselines.

We discussed the facts in this report with the acting director of OCRWM and other disposal program officials at DOE's headquarters and with YMPO's project manager in Las Vegas. These officials agreed with the facts discussed in this report, and we incorporated their comments as appropriate. However, as requested, we did not obtain written agency comments from DOE on a draft of this report. Our work was performed

⁷TRW Environmental Safety Systems, Inc., Mission 2001 Final Report (Sept. 18, 1992).

from June 1992 through March 1992 in accordance with generally accepted government auditing standards.

Low Funding Priority of Yucca Mountain Project Would Lengthen the Site Investigation and Increase Costs

DOE has been requesting far lower appropriations for characterizing Yucca Mountain than the agency had determined were needed to complete the task on schedule. This disparity is due to competition among all of the agency's programs for funds as well as competing priorities within the disposal program for nuclear waste from civilian nuclear power plants. The result has been that DOE made scientific investigations of the site a relatively low priority; for example, the agency spent only \$60 million of a \$275 million appropriation in fiscal year 1992 directly on scientific investigations. To meet its baseline schedule, DOE would in future years have to request and obtain even more funds than would be needed as estimated in its cost baseline; reduce the scope of site characterization; or adopt some combination of the two options. If DOE continues to request and allot funds for the Yucca Mountain Project at levels like those of recent years, site characterization could take at least 5 to 13 years longer than planned and increase the total cost of the disposal program.

DOE wants to change the way the disposal program is funded so that annual funding is based more on the program's needs rather than on the program's ability to compete with other programs for limited energy-related appropriations (budget authority). Although the agency has provided few details so far on this proposed change, it apparently wants to create a revolving fund for the program. From the perspective of DOE and those who pay disposal fees, such a change could permit increased application of the revenues in the Nuclear Waste Fund to accomplish the purposes for which the Fund was established. On the other hand, the proposed change has other ramifications that also need to be considered. Specifically, funding the program at higher levels by a revolving fund could increase the federal deficit unless spending reductions were also made in other federal programs, reduce congressional control over the program, and adversely affect the long-term financial health of the Nuclear Waste Fund.

Investigation of Yucca Mountain Is a Relatively Low Priority

For fiscal years 1991 through 1993, DOE's budget requests for the Yucca Mountain Project were a little over one-half of the amounts shown in the project's cost baseline for those years, and the agency's allotments of appropriated funds to the project were less than half of the baseline amounts. One reason for the funding disparity is that, under the federal government's budgeting procedures, the disposal program for civilian nuclear waste essentially competes with other DOE programs for funds. Also, DOE has used some program funds for monitored retrievable storage and transportation activities that support the agency's objective of

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 Investigation and Increase Costs**

beginning to accept nuclear waste by 1998. Finally, DOE has used a relatively large percentage of the funds made available to the project to maintain the project's infrastructure. Thus, relatively fewer funds have been available for the scientific and technical activities that DOE had determined are required to characterize the site.

**Disposal Program
 Competes With Other DOE
 Programs for Funds**

There is a significant gap between the amounts in DOE's baseline cost estimate for the Yucca Mountain Project and the amounts of funds that the agency has been seeking for and allotting to the project. In fiscal years 1991 through 1993, DOE allotted \$566 million to the Yucca Mountain Project. That amount is \$593 million less than the project's baseline cost estimate of \$1.159 billion for those years. (See table 2.1.) DOE did not, however, adjust the project's technical, schedule, and cost baselines to reflect the effects of the actual allotments of funds to the project. Instead, DOE deferred unfunded work to future years and assumed that appropriations in the future would be sufficient to fund all of the remaining work on schedule. To make up this shortfall, DOE would have to request, for each of the 8 fiscal years from 1994 through 2001, about \$74 million more than the amounts in the cost baseline. For fiscal year 1994, however, DOE prepared a proposed budget of \$262 million for the Yucca Mountain Project, or \$376 million less than the baseline cost estimate of \$638 million. The proposed amount would, if appropriated and allotted to the project, increase the gap between the baseline cost estimate and actual project funding over the last 4 years to \$970 million.

Table 2.1: Baseline Cost Estimates, Budget Requests, and Allotments of Appropriated Funds for the Yucca Mountain Project

Dollars in millions

Fiscal year	Baseline cost estimate	Budget request		Allotment	
		For the disposal program	For the Yucca Mountain Project	For the disposal program	For the Yucca Mountain Project
1991	\$194	\$293	\$193	\$243	\$155
1992	340	305	172	275	166
1993	625	392	248	375 ^a	245
Total	\$1,159	\$990	\$613	\$893	\$566

^aThe appropriation includes about \$275 million from the Nuclear Waste Fund and another \$100 million from DOE's appropriation for atomic energy defense activities.

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One reason for the gap between the baseline cost estimate for the Yucca Mountain Project and actual funding for it is that the disposal program competes, in a sense, with other DOE programs for funds. The Budget Enforcement Act of 1990 instituted procedures designed to reduce or limit the growth in the federal budget deficit each year through fiscal year 1995 by establishing, among other things, yearly spending limits on discretionary spending. Thus, although the disposal program is funded from a special fund in the Treasury, the program is in competition with all other discretionary spending programs for limited funding.

For each annual budget cycle, DOE receives guidance from OMB on the Department's total budget allocation and the allocations to each of its operating units, of which the disposal program is one. According to officials in OCRWM, the limits the Office places on budget requests for the Yucca Mountain Project reflect the progress on the project and the project's priority within DOE. The officials also stated that, because of the federal deficit and low appropriations for the Yucca Mountain Project in previous years, they are reluctant to forward budget requests for the project to OMB and to the Congress that do not sound reasonable.

For fiscal year 1993, DOE requested from the Energy and Water Development Subcommittees of the Senate and House Appropriations Committees appropriations totaling almost \$17.8 billion. The budget request for the disposal program, which totaled \$392 million, represented 2.2 percent of the total request. The Congress appropriated about \$17.2 billion to DOE, including an appropriation of \$275 million from the Nuclear Waste Fund. The Congress also earmarked \$100 million of DOE's appropriation for atomic energy defense activities, which was about \$12.1 billion of the agency's total energy and water development appropriation, for use in the disposal program. Accordingly, DOE actually received \$375 million of the \$392 million in appropriations that it had requested for the program.

Yucca Mountain Project
Also Competes With
OCRWM for Limited Funds

A second reason for the shortfall in funding for the Yucca Mountain Project is that the project has had to compete for limited funds within OCRWM. In particular, the project has competed for funds with activities concerning an MRS facility and the transportation of nuclear waste, which support DOE's objective of beginning to accept nuclear waste by the 1998 date specified in DOE's contracts for disposal services with owners and generators of waste. Furthermore, because DOE has used a relatively large percentage of the available funds to maintain the project's infrastructure,

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fewer funds have been available for the scientific and technical activities that DOE had determined are required to characterize the site.

OCRWM defines its mission as that of developing a total waste disposal system that includes transporting waste to an MRS facility and, later, to a repository; storing waste at an MRS facility until the waste can be shipped to a repository; and permanently disposing of the waste in the repository. In November 1989, the Secretary of Energy announced DOE's schedule for operating a repository in 2010 and an MRS facility as early as 1998. The Secretary's schedule for the latter facility assumed that the nuclear waste negotiator would be successful in his efforts to obtain a voluntary host for an MRS facility.

Thus, DOE established two program objectives of equal rank: (1) to begin accepting utilities' spent fuel in 1998 (by transporting it to an MRS facility for temporary storage) and (2) to begin permanently disposing of waste in a repository in 2010. To support these objectives, OCRWM divided the disposal program into three primary components supported by four secondary components. The first primary component, termed the "first repository program," consists mainly of the Yucca Mountain site characterization project and, to a lesser extent, technological activities concerning the repository but not directly related to site characterization. The other two primary components are the development of an MRS facility and a transportation system. Supporting these primary components are program management, technical support, systems integration, and engineering development.¹

Because the budget for the disposal program has not been sufficient to fund all of the program's activities at planned levels, according to the Office's director, OCRWM had to distribute available funds in such a way that did everything possible to meet both of its program objectives. Table 2.2 illustrates how, according to the director, OCRWM allotted the \$275 million appropriated by the Congress for fiscal year 1992. That amount was \$30 million less than DOE's budget request for the program.

¹Program management costs include compensation and benefits for DOE employees assigned to the disposal program, including the Yucca Mountain Project, and programwide contractual services and supplies. Technical support is research and development and other support that is not identified with a specific project but supports programwide objectives. Systems integration ensures that program components are properly integrated into the overall waste management system. Engineering development relates to the design and evaluation of subsystems and components required for the repository and/or the MRS facility.

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Table 2.2: Distribution of the Disposal Program's Funds for Fiscal Year 1992

Dollars in millions		
Program component	Budget request	Allotment
First repository	\$172	\$166
MRS facility	32	16
Transportation system ^a	39	34
Program management and technical support	62	60
Total^b	\$305	\$275

^aThe director of OCRWM included funding for systems integration and engineering development in this component.

^bAmounts in columns do not add to totals because of rounding.

In a January 1992 meeting with the Nuclear Waste Technical Review Board, the director of OCRWM stated that the office had allotted for the MRS facility and transportation system the minimum amounts of funds needed to meet the objective of accepting waste in 1998. DOE would not, he added, take any action, such as deferring the procurement of casks for shipping spent fuel to an MRS facility, that would clearly cause DOE to fail to meet its commitment to begin accepting spent fuel in 1998. The director also stated that, when faced with shortfalls in appropriations for the disposal program, as in fiscal year 1992, OCRWM would fund, in order of priority: (1) the foundation, or infrastructure, of the Yucca Mountain Project to maintain its continuity; (2) activities concerning the MRS facility and transportation system at levels sufficient to achieve the objective of accepting waste in 1998; and then (3) site characterization activities that would enable DOE to maintain the schedule for the repository.

This ranking of priorities has limited the progress in characterizing the site because, as shown in table 2.3, the scientific and technical activities that must be completed for this task have been last in line for funding. As the table shows, the amount of funds that DOE actually made available for scientific and technical activities—\$60 million—was about \$123 million less than the baseline amount of \$183 million.

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Table 2.3: Breakdown of Fiscal Year 1992 Funds Between Scientific and Technical Activities and Infrastructure Activities for the Repository

Dollars in millions

Activities	Baseline cost estimate		Budget request		Appropriation/allotment	
	Amount	Percent	Amount	Percent	Amount	Percent
Scientific and technical	\$183	54	\$79	46	\$60	36
Infrastructure	157	46	94	54	106	64
Total^a	\$340	100	\$172	100	\$166	100

^aAmounts in columns do not add to totals because of rounding.

Also, the amount of funds targeted for infrastructure activities—essentially maintaining the foundation of the project—increased from \$94 million, or 54 percent of the budget request, to about \$106 million, or 64 percent of the actual allotment of funds for the project. Thus, to sum up, in dealing with a \$30 million shortfall in funding for the entire disposal program, DOE allotted about \$6 million less than its request for the first repository component (as shown in table 2.2), and in assigning this shortfall, DOE reduced funding for scientific and technical activities by about \$18 million and increased funding of infrastructure activities by about \$12 million (as shown in table 2.3).

**Questions Raised About
 Program Objectives and
 Management**

DOE's dual objectives of beginning to accept waste in 1998 and to dispose of waste in 2010 and the way it has managed the disposal program in pursuit of both of those objectives have been questioned by us, the Nuclear Waste Technical Review Board, and to a limited extent, by the agency's own Energy System Acquisition Advisory Board. Also, DOE recently acknowledged that it is unlikely to be able to develop an MRS facility by 1998 and, therefore, is considering other ways to begin accepting waste by 1998.

In a September 1991 report, we concluded that it is highly unlikely that DOE can develop an MRS facility by 1998 because, among other reasons, it is unlikely that a state or Indian tribe would be willing to host an MRS facility.² We also stated that industry officials have said that utilities might sue DOE for breach of contract if DOE cannot take delivery of their waste after 1998. We discussed four possible interpretations that a court might construct in determining DOE's responsibilities under NWPA, as amended, and the

²Nuclear Waste: Operation of Monitored Retrievable Storage Facility Is Unlikely by 1998 (GAO/RCED-91-194, Sept. 24, 1991).

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disposal contracts. Despite these concerns, we noted that DOE had no contingency plans in case an MRS facility is not in operation by 1998. We recommended that the Congress withhold any future funds requested by DOE for site-related activities at least until DOE has demonstrated that a state or tribe has agreed, in principle, to host an MRS facility at a specific site and that DOE plan for the possibility that DOE cannot accept utilities' wastes in 1998. In a subsequent report, we also concluded that in the absence of an MRS facility, DOE would not need a program to procure large-scale casks for transporting nuclear waste until about 2005.³ We recommended that the Secretary of Energy limit funding for cask development activities to the amount necessary to complete final-design work planned for fiscal year 1992.

DOE disagreed with our conclusions and recommendations in both of our reports on the basis of its optimism that it would be able to develop an MRS facility by 1998. Although DOE acknowledged that no site for the proposed facility had been identified, the agency stated that it was using funds to (1) support the nuclear waste negotiator's voluntary siting process, such as by providing financial assistance to enable qualified jurisdictions to study the feasibility of hosting an MRS facility; (2) proceed with MRS facility design activities prior to identification of a host site; and (3) prepare for a future environmental review of a site and a facility license application. DOE also stated that it had decided to suspend further development of advanced-design casks for technical reasons and begin procuring casks that would use current technology to support starting up an MRS facility in 1998.

Subsequently, however, in a December 17, 1992, letter to the Chairman, Senate Committee on Energy and Natural Resources, the former Secretary of Energy acknowledged that the nuclear waste negotiator's efforts to find a site for an MRS facility had not been successful in identifying a candidate site in time to permit DOE to begin accepting waste in 1998. The Secretary outlined a strategy for providing interim storage for nuclear waste in 1998 that would, according to the Secretary, broaden and complement the negotiator's efforts. The strategy centered on providing for interim storage of waste at one or more federal sites beginning in January 1998 and refocusing the agency's activities related to an MRS facility and transportation system on the development of a standardized waste container system with capability for the storage, transport, and disposal of spent fuel.

³Nuclear Waste: Development of Casks for Transporting Spent Fuel Needs Modification (GAO/RCED-92-56, Mar. 13, 1992).

In a March 1993 special report, the Nuclear Waste Technical Review Board also concluded that insufficient time remains to find a voluntary host site and construct a facility to begin storing nuclear waste by 1998.⁴ The Board also expressed its concerns that DOE's allocation of a high proportion of site characterization funds to infrastructure activities leaves limited funding for important testing and research and that the large and unwieldy organizational structure of the program creates substantial program integration problems. According to the Board, DOE hired a management and operations contractor in 1990 to consolidate and integrate program activities but the contractor is not being used effectively and, therefore, this aspect of the disposal program remains a major problem that contributes to inefficiencies in the program. After noting that, at her confirmation hearing in January 1993 Secretary-designate O'Leary had suggested convening a broad-based group to review the disposal program, the Board recommended, among other things, that an independent evaluation of OCRWM's management and organizational structure be undertaken concurrently with ongoing work at Yucca Mountain.

Finally, in November 1992 DOE's Energy System Acquisition Advisory Board expressed its concern that the Yucca Mountain Project's technical, schedule, and cost baselines it had approved no longer reflected the actual funding for the project. At that time, the Under Secretary of Energy approved, on behalf of the Board, OCRWM's plans to start site preparation for and construction of the exploratory studies facility. In making this approval, the Under Secretary directed OCRWM to, among other things, revise the baselines according to the anticipated funding for fiscal years 1993 and 1994 and "achievable" funding in future years and present the results to the Board for its review in May 1993.

Completing the Approved Scope of Work Would Take Longer Than Planned and Increase Costs

For several reasons, including funding levels well below the baseline cost estimates, site characterization activities have been delayed since the schedule baseline was established, thereby jeopardizing DOE's chances of completing site characterization on schedule. Furthermore, if DOE continues to request and allot funds for the Yucca Mountain Project at levels similar to those of recent years, the agency clearly will not be able to complete the activities of the technical baseline by 2001. Extending the duration of the site characterization would increase the total cost of the disposal program.

⁴Special Report to the Congress and the Secretary of Energy (NWTRB, Mar. 1993).

**Site Characterization Has
Been Delayed**

In February 1992, the director of OCRWM testified that if the Congress treats DOE's fiscal year 1993 budget request favorably, the agency can continue its progress toward being able to permanently dispose of waste beginning in 2010.⁵ Nevertheless, scientific and technical work required for site characterization is not being completed on the schedule the Secretary of Energy established in November 1989, and according to OCRWM's deputy director, site characterization may already be too far behind schedule to enable DOE to submit a high-quality license application to NRC by 2001. For example, although DOE had planned to begin new surface-based scientific investigations in January 1991, it was not able to begin the work until July of that year.⁶ Also, when OCRWM received \$30 million less than it had requested in appropriations for fiscal year 1992, it deferred the procurement of equipment for use in constructing the exploratory studies facility. Instead, the Office limited the funding for the facility to design activities that, in the Office's judgment, would maintain the project's schedule.

Furthermore, the surface drilling program at Yucca Mountain has been slowed in part because of funding limitations. In this program, core samples of rock that are critical to determining the suitability of Yucca Mountain are extracted from the ground for study. As of October 1992, according to YMPO's chief of site investigations, the drilling program was 6 months behind schedule, and will continue to slip behind schedule by 3 to 6 months for each hole drilled. The schedule shows that completing the drilling program on time would require work 24 hours a day, 7 days a week, but current funding can only support a program functioning 8 hours a day, 5 days a week. At this rate, just collecting core samples for analysis will take from 3-1/4 to 6-1/2 years longer than planned.

**Funding at Present Levels
Would Extend the Time
Needed for Site
Characterization**

An independent review within DOE of the Yucca Mountain Project, completed in September 1992, concluded that site characterization could be completed on the agency's schedule only if the project is funded at or near the amounts in the approved cost baseline. At the levels of funding provided in recent years, we estimate that it could take at least 5 to 13 years longer than DOE anticipates to complete the scientific and technical activities that DOE has planned for characterizing the Yucca Mountain site.

⁵The director's statement was made before the Subcommittee on Energy and the Environment, House Committee on Interior and Insular Affairs, on Feb. 28, 1992.

⁶For a discussion of this delay, see our report Nuclear Waste: DOE's Repository Site Investigations, a Long and Difficult Task (GAO/RCED-92-73, May 27, 1992).

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DOE's Office of Procurement Assistance and Program Management independently estimated the cost to characterize Yucca Mountain.⁷ The Office estimated the cost of the exploratory studies facility and made independent estimates of other project costs. The Office's review team visited major contractors for the project; gathered data on the scope of work, the schedule, and the requirements for and availability of personnel; and assessed contractors' confidence in being able to accomplish the planned work and meet the schedule. The Office concluded that the project's baseline cost estimate of \$6.3 billion (in year-of-expenditure dollars) was reasonable for the anticipated scope of work and schedule and that meeting the scheduled date for the license application was possible if the required funding was made available. The Office also concluded that the schedule for the project would not be met if the project did not receive such funding. The Office did not, however, estimate how long characterizing the Yucca Mountain site might take at recent funding levels.

We made estimates of how long it could take DOE to complete site characterization if annual funding for the project continues at levels similar to or somewhat above DOE's recent budget requests and allotments of appropriations to the project. We assumed annual funding levels (in 1992 dollars) of \$200 million, \$250 million, and \$300 million for the project. (As shown in table 2.1, DOE's largest budget request and subsequent allotment of funds for the project in recent years were \$245 million and \$248 million, respectively. Also, the agency's budget request for the project in fiscal year 1994 was about \$262 million.) Using DOE's approved cost and schedule baselines for fiscal year 1992 through the project's completion, we first identified, in conjunction with YMPO officials, those costs that would be incurred to (1) perform the scientific and technical activities in the project's technical baseline and (2) maintain the project's infrastructure. (See table 2.4.)

⁷This independent cost estimate was conducted for DOE by a contractor which was independent of the project. The estimate was made for the agency's Office of Procurement Assistance and Program Management to determine the reasonableness of the project's scope of work, cost, and schedule.

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Table 2.4: Annual Baseline Cost Estimates for Site Characterization

Dollars in millions

Fiscal year	DOE's baseline cost estimate	Portion for			
		Infrastructure activities		Science and technical activities	
		Cost	Percent	Cost	Percent
Through 1991	\$1,068	\$498	47	\$570	53
Post-1991					
1992	\$340	\$157	46	\$183	54
1993	604	285	47	318	53
1994	597	319	53	279	47
1995	582	286	49	296	51
1996	579	294	51	285	49
1997	491	276	56	215	44
1998	443	258	58	184	42
1999	381	247	65	134	35
2000	327	225	69	101	31
2001	274 ^a	199	73	75	27
Subtotal	\$4,617	\$2,547	55	\$2,070	45
Total^b	\$5,685	\$3,045	54	\$2,640	46

Note: Costs incurred through 1991 are actual dollars spent through that year. Figures for all other years are estimates in 1992 dollars.

^aEstimate includes about \$12 million of post-2001 costs.

^bAmounts in columns may not add to totals because of rounding.

Source: Developed by GAO from data provided by DOE.

According to DOE's cost baseline, in round figures about 45 percent of the estimated cost to complete the project would be used for scientific and technical activities, and 55 percent would be used to support the project's infrastructure. Using this ratio of costs, we projected the number of years it would take to complete the scientific and technical work included in the technical baseline at the three selected annual funding levels. For example, at a funding level of \$200 million per year, we assumed that \$90 million, or 45 percent, would be spent on scientific and technical activities. We then calculated the number of years it would take, at this rate, to fund the \$2.1 billion in planned scientific and technical activities. (See app. I for a more detailed discussion of our methodology.) Our estimates show that at annual funding levels of \$300 million, \$250 million, and \$200 million (in 1992 dollars), it would take DOE until at least 2007, 2010, or 2014,

respectively, to complete the scientific and technical activities, or from 5 to 13 years beyond DOE's scheduled completion of site characterization in October 2001.

DOE officials agreed that continued funding of the project at the levels we selected would delay completion of site characterization beyond the agency's milestone of October 2001, but they neither concurred nor disagreed with the specific periods of delay that we estimated.

In our opinion, our estimates are conservative because they assume that, at funding levels consistently lower than the annual amounts in the cost baseline, DOE would be able to maintain the same ratio of spending on scientific and technical activities and infrastructure activities—45 percent and 55 percent—as projected in the baseline. As discussed earlier, however, in fiscal year 1992, DOE allocated 64 percent of the available funds to infrastructure activities because its top priority is to maintain the project's foundation. DOE allocated only 36 percent of the funds to scientific and technical activities. A similar situation occurred in fiscal year 1991. DOE's continued use of larger proportions of limited project funds for infrastructure activities, with relatively less funds used to conduct scientific and technical activities, could extend the duration of site characterization even further than we have estimated.

**Longer Period for Site
Characterization Would
Increase the Cost of the
Disposal Program**

DOE's Office of Procurement Assistance and Program Management also stated in its report that the most significant effect of low funding and a longer schedule for site characterization would be a higher cost for the project because of inflation, delays in planning, inefficiencies in staffing, and additional infrastructure costs attributable to the longer schedule. The Office did not estimate the potential increase in the cost of site characterization that would result from extending the task over a longer period. The Office did, however, estimate that at least \$60 million of infrastructure costs would be required each year to, among other things, retain institutional memory in the form of a core staff, produce all mandated reports and other documents, and meet obligations for financial and technical assistance granted to outside parties.

Because of uncertainty over how DOE might organize and conduct site characterization with sustained lower levels of funding, we did not estimate the potential increase in the total cost that could result from such funding. However, unless DOE reduces the proportion of project funds it has been spending on infrastructure activities and uses more of the

available funds for scientific and technical activities, the project's total cost, incurred over a longer period, will increase. The increase will occur because, for each dollar of scientific and technical work performed, DOE is incurring higher infrastructure costs than estimated in the project's cost baseline. As shown in table 2.4, for example, DOE estimated in the cost baseline that it would spend over \$2.5 billion on infrastructure activities and over \$2 billion on science and technical activities (in constant 1992 dollars) from fiscal year 1992 through the end of site characterization. Thus, for every dollar DOE expected to spend on science and technical activities, the agency estimated that it would spend about \$1.25 on infrastructure activities. In fiscal year 1992, however, DOE spent \$106 million on infrastructure activities and \$60 million on science and technical activities, or about \$1.77 on infrastructure activities for each dollar spent on scientific and technical activities. DOE's spending on the project in fiscal year 1991 was similar.

A longer site characterization period would also increase the disposal program's costs for the site characterization project that are not accounted for in the cost baseline. The total cost in the baseline includes only the estimated costs to DOE of its contractors working on the Yucca Mountain Project. The total does not include the project's share—about \$46 million in fiscal year 1992—of the costs of managerial and technical support for the disposal program. If the level of these costs remains the same, in real terms, through fiscal year 2001, they will amount to \$460 million. If, however, site characterization takes at least 5 to 13 years beyond 2001 to complete, as we have estimated, the project's share of these costs could add from \$230 million to \$600 million to the cost of the disposal program.

DOE Favors Changing Funding Method to Increase Annual Funding for the Disposal Program

DOE wants to change the disposal program's funding mechanism so that the program does not need to compete with programs funded from general treasury revenues and other special funds for limited appropriations (budget authority). DOE's view is that, because the program has a specific mission and is financed by the owners and generators of nuclear waste, the program should be funded on the basis of its need for funds rather than on its ability to compete with other federal programs for limited appropriations. Therefore, although the details of the proposal are sketchy and have at times been confusing, it appears that DOE would like to eliminate the existing practice of providing new budget authority for the program in annual energy and water development appropriation acts by establishing a revolving fund for the program.

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DOE's proposal would apparently make more of the revenues in the Nuclear Waste Fund available for the agency's use in implementing NWPA. On the other hand, other factors also need to be weighed in considering a specific proposal by DOE to change the way that funds are provided for the disposal program. From the standpoint of the overall federal budget, for example, such a proposal could, in comparison to recent levels of program appropriations and outlays (expenditures), result in a net increase in federal outlays unless spending was reduced in other areas and could reduce congressional oversight and control of the program. Furthermore, any significant increase in annual funding of the disposal program, whether achieved by changing the method for funding the program or by larger appropriations under the present method of funding, could, if not carefully monitored, adversely affect the long-term financial health of the Nuclear Waste Fund.

NWPA requires the Secretary of Energy to submit the budget of the Nuclear Waste Fund—the budget for the disposal program—to OMB for inclusion in the Budget of the United States Government and authorizes the Secretary to make program expenditures from the fund, subject to appropriations that remain available until expended. As discussed earlier, for example, in fiscal year 1993, DOE requested \$392 million for the program out of a total budget request of \$17.8 billion for energy and water development appropriations. The Congress appropriated \$275 million from the Nuclear Waste Fund and \$100 million from DOE's appropriation for atomic energy defense activities for the disposal program. And, for fiscal year 1994, the agency requested \$380 million for the program. Of this amount, DOE requested \$260 million from the Nuclear Waste Fund—\$15 million less than appropriated from the fund in the previous year—and \$120 million from its appropriation account for atomic energy defense activities.

The Nuclear Waste Fund is a special fund in the federal treasury generally comprising revenues from disposal fees paid by owners and generators of nuclear waste and interest earned on investment of revenues in excess of appropriations. Nevertheless, appropriations from the fund are, like appropriations from general treasury revenues and other special funds, subject to federal budget enforcement procedures. For this reason, DOE wants to change the way that funding for the disposal program is provided in the federal budget so more funds can be made available to meet the program's needs.

The former Secretary of Energy had proposed to OMB in a September 1992 letter that he would "submit [the disposal program] budget as a net zero

request for new budget authority by applying revenues to be paid into the Nuclear Waste Fund in FY [fiscal year] 1994 as an offset." In an April 1993 meeting, OCRWM's acting director told us that DOE had not yet decided that legislation creating a revolving fund would be the agency's preferred method of funding the disposal program. At this time, he said, DOE's position is that the agency favors removing the disposal program from the annual competition for energy and water appropriations but has not decided on the preferred method for accomplishing this objective. He added that DOE's rationale for removing the disposal program from this competition is that the program has a specific mission that is entirely financed by the owners and generators of nuclear waste; therefore, the program should be funded on the basis of its need for funds rather than on its ability to compete with other federal programs for limited appropriations.

However, on April 2, 1993, Secretary of Energy Hazel O'Leary announced a redirection of the disposal program. DOE's press release announcing the program's redirection stated, among other things, that one of the program's activities that would continue is "... a proposal for revolving fund legislation for congressional consideration." To that end, in an April 6, 1993, memorandum to OCRWM's acting director, the Secretary requested that such a proposal for legislation be developed.

Although the details of DOE's proposal are few, it appears that the purpose of establishing a revolving fund is to remove the program from the budget appropriation process. From DOE's perspective, this would remove the disposal program from the competition for spending authority as required by federal procedures for controlling the federal deficit. The proposal would also help ensure that revenues in the Nuclear Waste Fund are available to the agency to accomplish its objectives of timely acceptance and disposal of nuclear waste. Viewed from the perspective of DOE and the utilities who pay fees for nuclear waste disposal services into the Fund, therefore, DOE's proposal has the advantage of providing an increased level of revenues in the fund for the purposes for which the fund was established by NWPA.

On the other hand, other ramifications would need to be weighed in considering a specific proposal for funding the disposal program by means of a revolving fund. From a governmentwide perspective, for example, such a proposal could increase outlays, and the federal deficit, unless corresponding reductions were made in other programs. This would occur because, while projected revenues to the fund would not change, DOE's

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access to the revenues in the fund would increase. Also, if budget authority is provided in program legislation, the program would no longer be a discretionary spending program. Careful scrutiny must be given to any proposal that could move a program from the discretionary spending to the direct or mandatory spending side of the budget.

A revolving fund proposal could also result in more limited congressional oversight and control over the disposal program at a time when serious concerns about the program exist and the need for greater scrutiny by the Congress has been expressed. For example, the conference committee of the House and Senate Appropriations Committees in its reports on DOE's budget request for fiscal year 1993 stated that it was concerned about the "spiralling" cost estimates for site characterization, an overemphasis on funds for headquarters in comparison with those for the Yucca Mountain Project, and larger than necessary budget requests for the MRS facility and the waste transportation program. The conference committee added that, if there are not (1) meaningful progress in the characterization of Yucca Mountain; (2) a significant reduction in the size and expense of OCRWM's contractor for the disposal program; and (3) a redirection in the program's emphasis, the Appropriations Committees are prepared to give DOE, in future appropriation bills, specific line-item direction. This type of committee scrutiny might be missing with a revolving fund.

Finally, unless the adequacy of the disposal fees is carefully monitored and adjusted when warranted, any method of funding the disposal program, including the current method, that authorizes DOE to use significantly more of the Nuclear Waste Fund's revenues each year could lead to a shortfall in funds to pay the costs of the program once a repository has been constructed. For example, by 2010, utilities' nuclear power plants will, in increasing numbers, be reaching the end of their licensed, 40-year operating periods. As these plants are retired, the revenues from disposal fees will decline. However, the costs of shipping the waste to the repository and of operating the repository would still lie ahead for DOE. In its most recent projection of the cost of the disposal program, made in 1990, DOE estimated the cost to operate the program from 2010 until the projected end of the repository's operation in 2042 at about \$12 billion (in constant 1988 dollars).⁸ For this reason, any increase in the use of the fund's revenues at this time must be carefully monitored to ensure that the funds will be available to pay the costs of the program once a repository has been constructed.

⁸Preliminary Estimates of the Total-Cost for the Restructured [Civilian Nuclear Waste] Program (DOE/RW-0295P, Dec. 1990).

DOE's Efforts to Maintain the Project's Schedule and Reduce Its Cost Are Constraining Scientific Investigations Despite Emerging Technical Issues

DOE recently compressed the time allotted for various site characterization activities to maintain the Yucca Mountain Project's schedule and, in an attempt to reduce costs, may further reduce the scope of planned activities. Project scientists have expressed concern that these initiatives do not allow sufficient time to adequately investigate the site or to respond to unanticipated technical issues and, therefore, increase the risk associated with demonstrating that the site meets all requirements for licensing. Although DOE has always maintained that a demonstrably safe repository is of paramount importance, it has been criticized over the years for overly optimistic schedules for developing the repository. The former Secretary of Energy attempted to address this issue by committing DOE to ensuring that scientific investigations of Yucca Mountain would not be constrained by the agency's schedules.

At the same time that DOE is reducing the scope of the site characterization, the Nuclear Waste Technical Review Board has concluded that the agency may not be allowing sufficient time for complex technical issues that need to be studied to complete a scientifically sound license application. The Board urged, among other things, that DOE consider using a management approach in which schedules do not drive the scientific and technical aspects of the disposal program. Two technical issues—the management of heat generated by waste in the repository and new findings about a geologic fault at the site—that were not anticipated and remain open illustrate the importance of a thorough scientific investigation of the Yucca Mountain site.

Technical Aspects of Yucca Mountain Project Continue to Be Shaped by DOE's Schedule Objective

In September 1992, DOE completed a study to determine if submitting a license application to NRC in 2001 is still possible. The study concluded that, with adjustments in the scope of site characterization, meeting that date is a possibility at a total cost of about \$6.1 billion (in year-of-expenditure dollars). DOE is also studying ways to reduce the total cost of site characterization. On both initiatives, DOE's focus on reducing the scope of scientific work in order to maintain the project's schedule and reduce costs has raised concerns by project scientists about the scientific adequacy of the site characterization. DOE's initiatives demonstrate the difficulty the agency has had in reconciling the tension in NWPA between timely disposing of nuclear waste and ensuring that a repository is safe and environmentally acceptable.

**DOE Reduced the Scope of
Work to Maintain the
Project's Schedule**

In March 1992, OCRWM directed YMPO to conduct a comprehensive study of the Yucca Mountain Project, called "Mission 2001," to determine if, despite past delays, submitting a license application in October 2001 is still possible. YMPO's study, completed in September 1992, was performed by OCRWM's management contractor for the disposal program. The contractor concluded that it is possible to meet that date if adjustments are made to project contractors' scope of work, such as reducing the planned duration of some scientific activities. In conducting the study, YMPO and its management contractor assumed that the funding for the Yucca Mountain Project would be adequate to complete the activities necessary to meet the schedule.

At the outset of the study, YMPO instructed its contractors conducting scientific work to submit their requirements, in terms of funding and schedules, for completing work in order to meet the planned date for the license application. To meet that milestone, all data required for the application would have to be gathered by 1999, so the contractors would have to adjust the scope of their planned work as necessary. Upon receiving the contractors' estimates of requirements, YMPO integrated the information to determine if the target date of 2001 could be met. In cases in which contractors' submitted requirements could not be accommodated by the schedule, YMPO officials met with the contractors to agree upon reductions in the scope of their work. Thus, adjustments made during the study to contractors' scope of work compressed the time allowed for completing various scientific and technical activities.

The technical project officer of the Lawrence Livermore National Laboratory, which is responsible for developing the packaging for the waste to be put into a repository at Yucca Mountain, wrote in July 1992 to the manager of the Yucca Mountain Project that, although Livermore had complied with the Mission 2001 study's mandates, he and his technical staff had serious concerns regarding the study. He stated that they believed a credible license application could not be prepared by 2001, given the constraints prescribed in the study, such as (1) not deviating from a set work plan even though the evidence shows the need to, (2) satisfying the deadline whether doing so is technically feasible or not, and (3) operating with an unrealistically low budget in fiscal year 1993. He added that these constraints reflected a growing tendency by DOE to focus on superimposed milestones rather than genuine technical capabilities.

The Livermore technical project officer told us that he was particularly concerned with the fact that the Mission 2001 study required Livermore to

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reduce testing for determining the effects that heat emitted from stored waste would have on rock in the repository. Though the site characterization plan calls for this testing to last 5 to 7 years, YMPO's study reduced the time to 3 years, according to the project officer. He told us that such a reduction would seriously jeopardize the quality of a license application and that Livermore would not defend a license application containing data from only a 3-year test.

The technical project officer for the U.S. Geological Survey, which is responsible for much of the scientific evaluation of Yucca Mountain, also told us that some activities to gather scientific data were eliminated from the Geological Survey's scope of work as a result of the Mission 2001 study. He said that these reductions in the scope of work would result in less data to support earth science analyses and the consequent judgments. He added that, as a result of the study, some investigations, such as those evaluating potential seismic hazards, would not be pursued to the degree that had been previously planned. However, the technical project officer also told us that the scope of work derived from the study was comparable in quality and thoroughness to that of YMPO's original site characterization plan. In his opinion, although some of the tests deleted from the Geological Survey's scope of work had been included in the original plan, their elimination would not increase the risk of failing to obtain a license from NRC.

The Mission 2001 study showed that, to complete site characterization on time, annual funding from fiscal years 1994 through 1999 would have to be higher than the amounts in the approved cost baseline. This higher annual funding would make up for much of the funding shortfall that the project had. Overall, the study estimated that the total cost of site characterization would be about \$6.1 billion (in year-of-expenditure dollars). The estimated cost for scientific and technical activities and most infrastructure activities is about \$77 million above the original baseline cost estimate even after the scope of work has been reduced. Still, the total estimated cost for the project is \$200 million less than the amount in the cost baseline. The apparent savings result from reducing the benefits payments to the state of Nevada and recalculating technical assistance payments and other payments to the state, affected local governments, and universities.¹

¹The 1987 amendments to NWSA authorized the Secretary of Energy to enter into a benefits agreement with the state of Nevada, but such an agreement has not been negotiated. The original cost baseline included \$450 million (in year-of-expenditure dollars) for these benefits, but the Mission 2001 study included \$200 million for these payments.

YMPO's Cost-Cutting Effort
May Further Reduce Scope
of Work

In September 1992, OCRWM management directed YMPO to assess the Yucca Mountain Project with the objective of reducing its total cost. YMPO management hopes to be able to cut the cost by about 10 percent. Project contractors, however, are concerned that reducing their funding will also reduce the amount of scientific and technical work that can be completed and, therefore, jeopardize the scientific quality of the license application.

According to the manager of the Yucca Mountain Project, YMPO is looking for opportunities to cut costs by requesting that contractors examine their work plans and cost estimates and eliminate any conservatism in them. For the time being, he said, YMPO will proceed with the proposed cost, technical, and schedule baselines derived in the Mission 2001 study. Later, after YMPO has obtained all contractors' work plans and cost estimates, DOE management will determine if the cost-cutting reductions in the scope of work that have been proposed by contractors or YMPO would unreasonably jeopardize NRC's approval of a license for the repository. The project manager added that before DOE reduces or eliminates activities from the site characterization plan, it would seek NRC's acceptance of the measures.

Just as some contractors are concerned about reductions in the scope of work in order to meet the schedule, they are concerned about other reductions to cut costs. For example, though the technical project officer for the Geological Survey believes the reductions made under the Mission 2001 study do not increase the risk of failing to obtain a license from NRC, he stated in a September 1992 letter to the Yucca Mountain Project manager that further reducing the scope of the Geological Survey's scientific investigations would increase this risk by lessening the knowledge gained about the site. He pointed out that the site characterization plan contains a comprehensive earth science program and that reducing this program would not resolve some of the questions and concerns that have been raised by the National Academy of Sciences and the Nuclear Waste Technical Review Board. Some contractors we interviewed are concerned that, in order to cut costs or meet the date of 2001 for submitting a license application, DOE management will make arbitrary reductions in the scope of work without adequately considering the associated risks.

DOE Advisory Board Is
Concerned About the
Project's Cost and
Schedule

The Under Secretary of Energy, in the November 1992 letter giving OCRWM the approval of DOE's Energy System Acquisition Advisory Board to start the site preparation for and the construction of the exploratory studies facility, stated that it is critical for DOE to develop a strategy for reducing

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the cost of the Yucca Mountain Project and that OCRWM should examine the options available for restructuring the project. Therefore, he directed OCRWM to, among other things, (1) identify the minimum requirements for characterizing the site and completing a license application, with the objective of reducing costs and accelerating the project and (2) recommend a way to expand the role of the National Academy of Sciences in reviewing the project.

The Under Secretary directed that OCRWM report in May 1993 on these assignments. The Yucca Mountain project manager told us that (1) DOE has received a clear message from the Congress to cut the cost of this project and (2) that is what the agency is trying to do. He went on to say that while reducing the project's scope of scientific work will increase the risk of not receiving NRC's approval for a license, the decision of whether to take such a risk will be DOE management's.

DOE Has Not Reconciled
the Tension Between
Meeting the Schedule and
Ensuring Safety

One apparent reason for DOE's continuing aggressive efforts to adhere to its schedule for developing a repository is the inherent tension within NWPA between the timely resolution of the nation's problem of disposing of nuclear waste and the need to ensure that the public and the environment are adequately protected from the hazards posed by this waste. On the one hand, NWPA established an ambitious schedule that included interim milestones—for instance, for the President to recommend to the Congress, by March 31, 1987, a qualified site for a repository. On the other hand, the Congress found that appropriate precautions must be taken to ensure that highly radioactive waste does not adversely affect public health and safety and the environment for this or future generations. Thus, the act provided opportunities for participation in the program by potentially affected states, local governments, and Indian tribes and required the Secretary of Energy to obtain from NRC a license to construct the repository.

In its original mission plan for the disposal program, DOE recognized the tension between the schedule and what it called "technical certitude."² In that plan, DOE stated that protecting public health and safety and the environment was of paramount importance but also established an "aggressive but achievable" objective of accepting waste for disposal by January 31, 1998. Although DOE recognized the potential for delay, it said that NWPA clearly required DOE's best effort to open the repository by that date.

²NWPA, as amended, required the Secretary of Energy to prepare a comprehensive mission plan that would provide a sufficient basis for making informed decisions in carrying out the program.

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In a June 1987 amendment to the mission plan, DOE extended by 5 years, to 2003, its date for beginning operations at the repository because of a low budget in fiscal year 1987, uncertainty about the budget for fiscal year 1988, and a recognition that selecting a repository site and preparing a license application would require more information than previously planned. As DOE pointed out, many parties had commented that, given the controversial nature of the disposal program, the schedule specified by NWPA was not achievable and could not be reconciled with the siting process mandated by the act. DOE added that it had developed an aggressive schedule for opening a repository but had also insisted that the schedule would not be allowed to prevail over the need for technical excellence and public participation. Finally, DOE stated that its new schedule remained "aggressive and success oriented."

Nevertheless, in September 1988, NRC commented that, in response to delays in starting site characterization, DOE was compressing the time allowed to investigate the Yucca Mountain site. Then, in July 1989, NRC expressed concern that the pressure to meet unrealistic milestones could lead to an insufficient technical understanding of the site and the subsequent failure to complete and submit a high-quality license application.³

The Secretary of Energy, in his November 1989 announcement that he was extending the repository's scheduled opening from 2003 to 2010, described the repository as a technically and institutionally unprecedented project and stated that DOE had underestimated the effect of regulatory requirements on the schedule. The initial schedule was unrealistically ambitious, he explained, and DOE had incorrectly perceived that the project was simply a construction project rather than a first-of-its-kind scientific investigation. The Secretary also said that the scientific investigation would be the focal point of the program to ensure that the results are technically sound and not biased by a scheduling process that constrains the time required to gather sufficient information. As demonstrated by YMPO's Mission 2001 study, however, DOE continues to emphasize meeting its schedule for operating a repository.

³NRC Staff Site Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards (NUREG-1347, Aug. 1989).

Emerging Technical Issues Illustrate the Need for a Thorough Scientific Investigation

The Nuclear Waste Technical Review Board, in its June 1992 semiannual report on DOE's disposal program, stated that there are significant uncertainties related to the agency's program schedule.⁴ The Board expressed concern that DOE's reliance on the current schedule may not allow sufficient time to (1) collect and analyze some data, (2) resolve unanticipated technical problems and questions about unpredictable conditions important to the repository's performance, and (3) evaluate the repository's design and the alternatives for the waste management system.

The Board reiterated its concern about the schedule in its December 1992 semiannual report⁵ and in its March 1993 special report. In the former report, the Board urged DOE to consider for the disposal program a management approach in which existing schedules, such as those for the operation of the repository, are taken seriously but do not drive the program's scientific and technical goals. The Board said it is concerned that attempting to meet unrealistic long-term deadlines may force DOE to make important technical decisions without first performing the appropriate technical and scientific analyses. In the latter report, the Board stated that, given all of the necessary scientific, regulatory, and institutional activities integral to developing the repository, the assumption that a repository will be operating by 2010 seems optimistic.

Unanticipated technical issues have surfaced that illustrate the Nuclear Waste Technical Review Board's concern over DOE's schedule. For example, the Board is concerned that DOE's strategy for managing the heat generated by spent fuel in the repository over thousands of years is not supported by scientific evidence, and therefore, the Board has recommended that the agency complete extensive, previously unplanned, testing. In addition, new findings at the Ghost Dance Fault at Yucca Mountain could affect the time needed to adequately characterize the site.

Decisions About Handling the Heat From Waste Could Affect Scope of Disposal Program

Because of the decay of radioactive materials in nuclear waste, it will continue to produce heat for thousands of years after its disposal in a repository. The Nuclear Waste Technical Review Board, in its March 1990 semiannual report on the disposal program, described this issue, called thermal loading, as one that would largely determine the level of uncertainty about the repository's performance over a long period of time. In its June 1992 semiannual report, the Board stated that the strategy eventually used to control the temperatures in a repository is a

⁴Fifth Report to the U.S. Congress and the U.S. Secretary of Energy (June 1992).

⁵Sixth Report to the U.S. Congress and the U.S. Secretary of Energy (Dec. 1992).

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fundamental decision in the disposal program because the selected strategy will affect most components of the waste management system, including the methods for storing and transporting the waste; the design of the waste package; and the repository's size, design, performance, and cost.

Because of the significance that the Board attached to the issue of thermal loading, the Board addressed it at a meeting in October 1991. At that meeting, DOE discussed its strategy, described in the Yucca Mountain Site Characterization Plan, for managing heat in a repository at that site. The Board was also briefed by waste disposal experts from Canada, Germany, and Sweden. According to the Board's June 1992 report, DOE planned to emplace, beginning in 2010, 70,000 metric tons of spent fuel in the repository in such a way that the temperature of the rock around the packages containing this waste would remain above the boiling point of water for 300 to 1,000 years.⁶ This heat would, the Board said, drive away any moisture that might otherwise reach the waste packages and, in theory, prevent or greatly retard corrosion of the packages for at least 300 years.

According to the Board, there are other strategies concerning thermal loading, two of which were discussed in the Board's June 1992 report. One alternative strategy is to load the repository in a way that would keep the temperature of the waste and the repository rock near the waste above the boiling point for water—and thus keep moisture away from the waste—for 10,000 years. This time period is the one specified in waste disposal regulations issued by the Environmental Protection Agency in 1985.⁷ According to the Board, this strategy could have at least three implications for the disposal program:

- The repository planned for Yucca Mountain could accommodate spent fuel in excess of 150,000 metric tons, possibly eliminating or postponing for several decades the need to develop a second repository.
- Spent fuel would have to be aged (stored) for about 60 years to reduce its high initial temperatures and then would have to be packed more densely in the repository to maintain conditions above the boiling point.

⁶NWPA limits the quantity of waste that NRC can authorize for disposal in the first repository to 70,000 metric tons.

⁷The Environmental Protection Agency is revising these regulations because of a 1987 court decision and the Energy Policy Act of 1992.

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- Like DOE's proposed strategy, this alternative strategy could be perceived by the scientific and technical communities as evoking more uncertainties than a strategy that would keep temperatures below the boiling point.

A second alternative strategy discussed by the Board is to keep the temperature of the host rock below the boiling point of water. According to the Board, this strategy does not rely on heat to protect the waste packages from water; however, this strategy would reduce stresses in the rock caused by thermal expansion and might make the rock's properties and behaviors more predictable. A potential disadvantage of this strategy, the Board said, is that the planned repository could have less capacity for the disposal of waste or, alternatively, that a larger repository than now planned could be needed.

According to the Board, there is no scientific evidence to support DOE's proposed strategy over the alternative strategies. Until this fundamental issue is resolved, the Board said, DOE cannot complete the designs for the waste package and the repository or submit a good-quality license application. Therefore, the Board recommended, among other things, that DOE thoroughly investigate alternative strategies that are not overly constrained by a desire to rapidly dispose of spent fuel. The investigation, the Board said, should involve a systematic analysis of the technical advantages and disadvantages of each alternative strategy and each strategy's implications for other aspects of the waste management system.

In its written response to the Board's recommendation, DOE said that it is investigating a range of alternatives and that a project team is conducting a study to ensure that the effects of each alternative strategy on all components of the waste management system are thoroughly analyzed. According to YMPO officials, the team will determine what tests are required to identify the optimal temperature for waste stored in the repository for thousands of years and how the temperature at which waste is stored will affect other systems within the repository. According to YMPO officials, after scientists begin to understand what the consequences would be of storing waste at various temperatures, YMPO will still need to resolve design and operational issues of the tests, consider the tests' implications for the waste system, and begin the required testing itself. Until the tests are conducted, neither the design of the waste package nor the design of the repository can be completed. According to these officials, it will take at least 2 years to decide how to handle thermal loading.

**Studying Ghost Dance
Fault May Require
Additional Resources and
Time**

Recent findings by the Geological Survey indicate that the Ghost Dance Fault, which crosses Yucca Mountain, may be a more complex geologic formation than originally thought. If this is the case, according to officials of the Geological Survey, their examination of the site may need to be expanded. The results of the examination could affect the location and design of the repository, as well as a determination about the suitability of the site.

According to the head of the Geological Survey's rock mechanics section for the Yucca Mountain Project, the Ghost Dance Fault crosses Yucca Mountain, south to north, through a portion of the area proposed for the repository. In December 1991, the Geological Survey began to examine the surface of portions of the fault in much greater detail than had been done previously.⁸ This detailed examination provided evidence that the Ghost Dance Fault is not merely a single fault but is the main fault of a complex fault zone.

What geologists do not yet know is whether this fault zone runs the entire length of the Ghost Dance Fault and what the depth of the fault zone is. To determine the extent of the complex fault zone, the Geological Survey expects to do additional detailed examinations along the surface of the fault in 1993. To determine the depth of the fault zone, agency officials proposed to YMPO that the agency do testing beneath the surface in 1994 after the construction of tunnels for the exploratory studies facility has started.

The technical project officer characterized the scientific investigation of the Ghost Dance Fault as an example of how unanticipated geologic findings might require additional resources and time for further investigation. Moreover, in his opinion, YMPO's planned reductions in site characterization activities in an effort to reduce costs would not allow the Geological Survey either the time or financial resources to resolve this geologic issue. Of concern to the agency is that the original examination of the Ghost Dance Fault, from aerial mapping, did not show the complex fault zone. According to the agency's Chief of Rock Characteristics, this could also be the case for other surface areas of Yucca Mountain that, until now, have only been studied through aerial mapping. This official believes that other surface areas of Yucca Mountain where the repository would be sited should be examined in the same way that the Geological Survey is examining the Ghost Dance Fault. Such studies would require additional

⁸Prior to December 1991, the examination of the Ghost Dance Fault had been done through the use of aerial maps at a scale of 1 inch to 1,000 feet. Beginning in December 1991, the Geological Survey began a surface mapping study of the southern portion of the fault at a scale of 1 inch to 20 feet.

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time and resources, he said, but would provide a better understanding of the site.

Conclusions and Recommendations

NWPA created tension in the disposal program between the expeditious development of a repository and other requirements, such as ensuring a safe repository and meaningful public participation. DOE has consistently maintained that the safety of the repository is of primary importance. However, DOE's objectives and schedules for the disposal program have continually been optimistic. At the present pace, completing all of the technical activities derived from the Yucca Mountain Site Characterization Plan will probably take at least 5 to 13 years longer and will cost more than the agency has estimated. Thus, it is unlikely that DOE will be ready to begin disposing of waste in a repository until 2015 or later. And, by DOE's own recent acknowledgement, the agency's policy of developing an MRS facility for use to store waste between 1998 and the opening of a repository has not been successful.

DOE's overemphasis on its schedules for operating a repository and accepting waste is illustrated by its failure to factor realistic assessments of disposal program funding into its program plans and schedules. The agency's recent budget requests for the entire program have been less than the amounts that DOE had estimated were needed to maintain just its site characterization schedule. Moreover, characterization of the Yucca Mountain site competes for a limited disposal program appropriation with activities that support the overall program and DOE's objective of beginning to accept nuclear waste as early as 1998. DOE, however, did not take potential funding constraints into account when it established its schedule for completing site characterization in 2001. Then, when actual budgets for and allotments of appropriations to the project were less than the agency's estimates for maintaining the project's schedule, the agency compounded this omission by assuming that shortfalls in funding would be made up over the remainder of the project's schedule instead of adjusting the schedule to reflect actual project funding.

Furthermore, although the ultimate objective of NWPA, as amended, is the potential development of a repository, DOE's priorities for using the funds requested and appropriated for the disposal program have not emphasized the investigation of Yucca Mountain for that purpose. In the face of the disposal program's relatively low priority for funding, DOE has continued to pursue its dual objectives of developing a repository by 2010 and accepting utilities' waste in 1998 instead of concentrating the program on the characterization of the Yucca Mountain site. DOE's policy has affected progress on the Yucca Mountain Project in two ways.

First, DOE has used some of the program's limited funds on activities regarding the MRS facility and transportation system in an effort to begin accepting nuclear waste for storage by 1998. The Congress's decision to tie the development of an MRS facility to the progress made on the repository project, however, suggests that the Congress found DOE's ability to begin storing spent fuel by 1998 less important than ensuring continued progress on a repository. Moreover, this view was reaffirmed when the conference committee of the House and Senate Appropriations Committees expressed its concerns about DOE's request for more money in fiscal year 1993 than the conferees thought was necessary for the MRS facility and the transportation system.

Second, in fiscal years 1991 and 1992, DOE used over 60 percent of the funds that it allotted to the repository project to maintain the project's infrastructure. As a result, DOE used a relatively small amount of the program's funds—\$60 million out of an appropriation of \$275 million in fiscal year 1992—to perform essential scientific and technical activities at Yucca Mountain.

DOE has responded to the disposal program's current dilemma by (1) revising the baselines for the project in light of actual and projected funding, (2) reducing the scope of site characterization in an effort to adhere to its schedule and reduce costs, and (3) deciding to develop proposed legislation that would change the way the funds are provided for the program so that annual funding is based on need rather than ability to compete with other programs for limited appropriations. The agency's initiatives fall short of the mark, however, because they address specific problem areas perceived by DOE but do not comprehensively address the central condition of the program that has been exacerbated, if not caused by, the disconnection between program funding and DOE's program policies.

Specifically, utilities believe that DOE is obligated to begin accepting their nuclear waste in 1998 and have said that they might sue DOE for breach of contract if the agency does not meet that obligation. Nevertheless, although DOE gave relatively high priority for funds to accepting waste by 1998, it is now almost certain that DOE will not have an MRS facility available by then and it is uncertain whether any state or Indian tribe will volunteer to host an MRS facility on any schedule. Furthermore, the prospective time that DOE might have a permanent repository operational keeps receding farther into the future, in part, because of the relatively low funding priority the agency has assigned to essential scientific and

technical activities at Yucca Mountain. These conditions raise significant questions about the pace and direction of the program that must be answered if the program is to proceed in an orderly fashion:

- What are the federal government's obligations to begin accepting nuclear waste in 1998?
- How can considerations about site characterization be separated from considerations related to the temporary storage of nuclear waste until a repository for permanent disposal of the waste has been developed?
- Should essentially all of the funds appropriated for the program be used to characterize the Yucca Mountain site?
- Can sufficient funds be made available to characterize the Yucca Mountain site, meet short-term program objectives that may be appropriate, and ensure that the Nuclear Waste Fund remains solvent over the long term?
- How might DOE reorganize and manage the Yucca Mountain Project to increase the efficiency with which it uses funds allotted to the project and, therefore, minimize the duration and cost of site characterization?

These questions are not all-inclusive of the nuclear waste disposal issue but are ones that arise from the scope of our review. Furthermore, some of these questions address basic policy issues pertaining to the management and disposal of nuclear waste. For this reason, we agree that an independent review of the disposal program, as recommended by the Nuclear Waste Technical Review Board, is in order, and in an upcoming report on the disposal program, we will suggest ways that such a review might be carried out and will raise other questions that may also need to be addressed. Meanwhile, it is imperative that DOE, as the federal agency charged with implementing the disposal program, address questions pertaining to the interrelationships between program funding and objectives and how the Yucca Mountain Project should be organized and managed before asking the Congress to change the method by which the program is funded.

Recommendations to the Secretary of Energy

Because of concerns over the slow pace and fragmented direction of the nuclear waste disposal program, we recommend that the Secretary of Energy review the program's goals and objectives in the context of the present program's low funding priority. Such a review should address the sufficiency of the program's emphasis on the scientific investigation of Yucca Mountain and how that project can be conducted more efficiently without sacrificing the technical quality of the investigation. In conjunction, the Secretary should review the project's technical, schedule,

and cost baselines each year and adjust them as appropriate in view of actual allotments of funds to the project, realistic assessments of future funding for the project, and progress in resolving technical issues.

Recommendation to the Congress

In view of the current status of the disposal program, we recommend that the Congress defer consideration of legislation that would change how funds are provided to DOE from the Nuclear Waste Fund for use on the disposal program until (1) the Secretary of Energy has completed the review of the program that we recommended; (2) an independent review of the program, such as that recommended by the Nuclear Waste Technical Review Board, has been completed; and (3) appropriate legislative, policy, and/or programmatic changes to the program have been implemented.

Methodology for Estimating Duration of Site Characterization at Selected Funding Levels

The Department of Energy's (DOE) budget requests for and allotments of appropriated funds to the Yucca Mountain site characterization project were almost \$600 million lower than the agency's approved baseline cost estimate for fiscal years 1991 through 1993. As a result, scientific and technical activities necessary to characterize Yucca Mountain were not funded at the level required to maintain the schedule for submitting a license application in 2001. We estimated how long it could take to complete site characterization at funding levels similar to and somewhat above the amounts that DOE has been requesting for and allotting to the project. We found that funding the project at the levels we selected would add 5 to 13 years to DOE's site characterization schedule. This appendix describes the methodology we used to make these estimates.

DOE's baseline cost estimate for characterizing the Yucca Mountain site is about \$5.7 billion (in constant 1992 dollars), of which \$4.6 billion would be spent in the 10-year period from fiscal year 1992 through fiscal year 2001. (About \$12 million of this amount would actually be spent in fiscal year 2002.) The project has two basic types of costs—the costs of scientific and technical activities and of infrastructure activities. The costs of scientific and technical activities essentially are the direct costs of investigating the site. These activities include collecting and analyzing site-specific scientific data; developing a package for disposing of waste; establishing the technological basis for the repository; and designing, constructing, and operating an underground facility for site characterization activities. Infrastructure costs are incurred, according to DOE, to (1) manage the activities of the project's contractors; (2) provide financial and technical assistance to Nevada, local governments, and the University of Nevada; (3) operate and maintain facilities and equipment; (4) comply with applicable laws and regulations; and (5) provide training to project staff, public outreach, and a quality assurance program. Table I.1 breaks out the total estimated cost of \$5.7 billion (in constant 1992 dollars) by the cost of various components of the project.

**Appendix I
Methodology for Estimating Duration of Site
Characterization at Selected Funding Levels**

Table I.1: Estimated Costs of Infrastructure Components and Scientific and Technical Components of Site Characterization

Dollars in millions	
Project's component	Baseline cost
Infrastructure	
Systems—Managing site characterization activities to comply with regulatory requirements	\$440
Regulatory and institutional—Interacting with project regulators, Nevada, local governments, and the public	382
Project management—Managing the activities of contractors	1,003
Financial and technical assistance to Nevada, local governments, and universities	903
Test facilities and land acquisition—Acquiring land and developing and operating facilities supporting field work for site characterization	317
Subtotal	\$3,045
Scientific and technical	
Site—Collecting and analyzing site-specific scientific data	\$1,113
Waste package—Designing, constructing, and qualifying a package for the safe handling, storage, and containment of nuclear waste	273
Repository—Establishing the technological basis for ensuring the containment of waste in the repository	451
Exploratory studies facility—Developing and operating a facility for activities concerning underground investigations	803
Subtotal	\$2,640
Total	\$5,685

The first step in our methodology was, through discussions with project officials, to divide DOE's baseline cost estimate for the 10-year period beginning in fiscal year 1992 into the estimated annual costs of scientific and technical activities and infrastructure activities. From this information, which is shown in table 2.4, we determined that over the 10 years, about \$2.1 billion, or 45 percent, of the project's cost would be for scientific and technical activities and about \$2.5 billion, or 55 percent, for infrastructure activities. In our calculations, we did not include funding occurring before 1992. Had we included funding in these earlier years, the portion of funding devoted to scientific and technical activities would be 46 percent, and the portion for infrastructure activities would be 54 percent.

Second, we selected hypothetical annual funding levels of \$200 million, \$250 million, and \$300 million (in 1992 dollars) beginning in fiscal year 1992 and running out through the project's completion. The two lowest funding levels are similar to the amount of funds that DOE requested for the

**Appendix I
Methodology for Estimating Duration of Site
Characterization at Selected Funding Levels**

Yucca Mountain Project in recent years.¹ The highest selected funding level is about \$50 million more than DOE's budget request for fiscal year 1993.

Third, we divided each selected funding level into the amounts for scientific and technical costs and infrastructure costs, using the historical percentages, 45 and 55 percent, respectively, for each type of cost. For example, at annual funding of \$200 million, we assumed that \$90 million would be used for scientific and technical activities and \$110 million for infrastructure activities.

Fourth, we calculated the number of years it could take to complete almost \$2.1 billion of scientific and technical activities assuming that 45 percent of the project's annual funding was used for these activities. For example, at funding of \$200 million per year beginning in fiscal year 1992, we assumed that \$90 million of the funds would be used each year for scientific and technical activities. At this rate, it would take 23 years (\$2.07 billion/\$90 million per year = 23 years), or to about the end of 2014, to complete these activities. At \$250 million per year, it could take over 18 years, or until sometime in 2010, to complete site characterization. Finally, at funding of \$300 million per year, it could take over 15 years, or until early in 2007, to complete site characterization.

¹DOE's budget requests for fiscal years 1991, 1992, and 1993 were \$193 million, \$172 million, and \$248 million, respectively.

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Related GAO Products

Transition Series: Energy Issues (GAO/OCG-93-13TR, Dec. 1992).

Nuclear Waste: Status of Actions to Improve DOE User-Fee Assessments (GAO/RCED-92-166, June 10, 1992).

Nuclear Waste: DOE's Repository Site Investigations, a Long and Difficult Task (GAO/RCED-92-73, May 27, 1992).

Nuclear Waste: Development of Casks for Transporting Spent Fuel Needs Modification (GAO/RCED-92-56, Mar. 13, 1992).

Nuclear Waste: Operation of Monitored Retrievable Storage Facility Is Unlikely by 1998 (GAO/RCED-91-184, Sept. 24, 1991).

Nuclear Waste: Changes Needed in DOE User-Fee Assessments (GAO/RCED-91-52, May 8, 1991).

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